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INTELLIGENT ECG MONITORING USING BIOTELEMETRY

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Abstract

Heart rate is the number of times the heart beats per minute. Heart rate is a very vital health parameter that is directly related to the soundness of the human cardiovascular system. While the heart is beating, it is pumping blood throughout the body, and that makes the blood volume inside the finger artery to change too. This fluctuation of blood can be detected through a pulse sensing mechanism placed around the fingertip. So, every time the heart beats the amount of reflected which can be detected by the sensors with a high gain amplifier. This little alteration in the amplitude of the reflected light can be converted into a pulse. The possibility of a heart attack would be decreased and many lives would be saved by this real-time monitoring of a patient's heart. These systems acquired data may be used further for analytical purposes. Health Care Tracking is done by Fitness Trackers, Smart Fitness Watches and Portable ECG Sensors. This paper describes a technique of measuring the heart through a microcontroller and few other sensors to check whether heart is functioning in a proper manner or not.

Keywords

Embedded Systems, IoT, ATmega8, Sensor Integration

1. Introduction

The Electrocardiogram (ECG) is an estimation of the electrical action of the heart after some time, caught and remotely recorded as estimated by skin terminals. The signs demonstrate the general cadence of the heart and shortcomings in various pieces of the heart muscle. This strategy is the most ideal approach to gauge and analyse strange rhythms of the heart, and is usually utilized in medical clinics everywhere throughout the world. It is additionally utilized in sports and military conditions for cutting edge diagnostics of healthy people.

As of late, the exploration network has been dynamic in quest for advancements for a "Remote ECG" where patients are not, at this point required to be connected to a huge fixed gadget while their ECG signals are observed. A significant help behind this pattern is the decreased human services expenses of remote observing, where patients can live in their homes as opposed to involve a medical clinic bed. Numerous frameworks have been proposed to achieve this accomplishment, with changing objectives and approaches. Remote ECG checking should be possible utilizing 3, 4, 5 or 10 sensors, giving progressively itemized data to cardiologists.

The circuitry which is used for capturing and monitoring the data is wearable in nature, which further is transmitted to a close by receiving device. Receiving device can be of both type simple or complex, basic logging or analysis device in case of simple receiving device whereas large hospitals where ECG data is collected actively wirelessly from multiple patients at a time in case of complex receivers. There are two categories in which a wireless ECG system is grouped i.e., first group being the systems with wired sensors which allows patients to be free from being tied to the bulky equipment and for connecting all the sensors to central PDA- sized device it uses physical wires in order for transmission of data to the monitoring systems wirelessly, and another group being systems with wireless sensors.

2. Literature Review

Research is focusing on developing smaller, more comfortable ECG monitoring devices that can be worn discreetly for long periods. These devices can provide continuous monitoring, allowing for early detection of cardiac abnormalities.

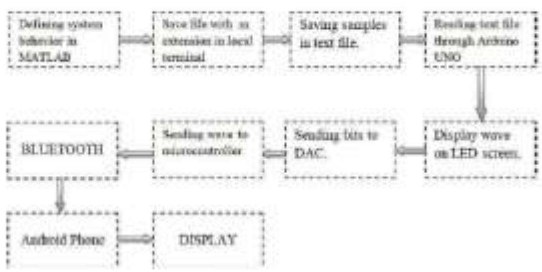
There is ongoing research into improving the biotelemetry technology used to transmit ECG data wirelessly. This includes developing more efficient data compression algorithms, enhancing signal processing techniques, and improving the security of data transmission.

Research is exploring how wireless ECG monitoring combined with telemedicine can improve access to healthcare, especially in remote or underserved areas. This research includes developing mobile applications for remote ECG monitoring and integrating ECG data into electronic health records.

3. Proposed System

The solution of this project is to develop a method that aims to wireless ECG monitoring of heart activity for patients with heart diseases, faulty pacemakers, and other special heart conditions in order to enable a patient to lead an active life without being confined to various restrictions or specific region. Being able to monitor sick patients remotely, Peace of mind can be obtained by the family after being able to monitor sick patients remotely, as they know that emergency services will be dispatched if any emergency like cardiac arrest or irregular heart patterns occurs.

4. Hardware Implementation



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5.Methodology

Generating Code Through Matlab

For specialized figuring MATLAB is considered as a superior language. It incorporates computation, perception, and writing computer programs is coordinated in a situation which is effectively utilized by people, and where fundamental scientific documentation is utilized for communicating issues and arrangements.

Together P, Q, R, S, T and U waves as appeared underneath is utilized to speak to a fundamental ECG wave structure. Q, QRS, S waves and P, T, U waves can be spoken to by triangular and a sinusoidal waveform individually. By the expansion of these waves an ECG sign can be created. Fourier arrangement is utilized to speak to an ECG wave as it is intermittent in nature.

Modelling of Basic ECG signal using Fourier Series: It is Shown below

F(x) =0 2[ancos(nwx) + bnsin(nwx)] + Σ∞=1 Where,

F(x)—› represents instantaneous amplitude of an ECG signal.

0 —› constant, representing average amplitude value.

X —› variable representing angular

T—› period of ECG signal.

, —›Fourier coefficient.

0, and are calculated by given formulas:

ao = 2/T ∫ () dx() cos(nwx)dx0

an 0= 2/T ∫

bn= (2/T) ∫ () sin(nwx)dx

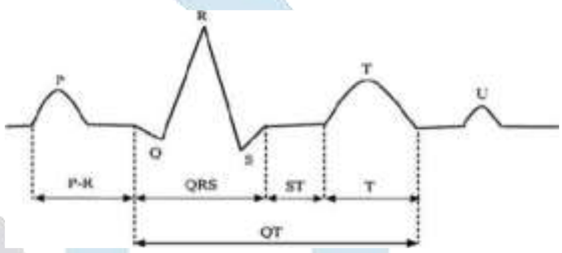
Modelling Of Q, Qrs and S Waves with Fourier Series:

Q, QRS and S waves can be assumed in triangular waveform as below. Let the period of signal be equal to T = 2l and it is assumed that the amplitude of signal, f(x) can be calculated as,

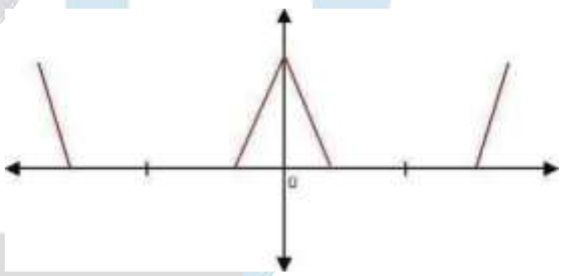
((-bax/l) +a) if (0<x<(1/b)

f(x)=0 if x=0

((bax/l) +a) if ((-1/b) <x<0)



A basic ECG Signal



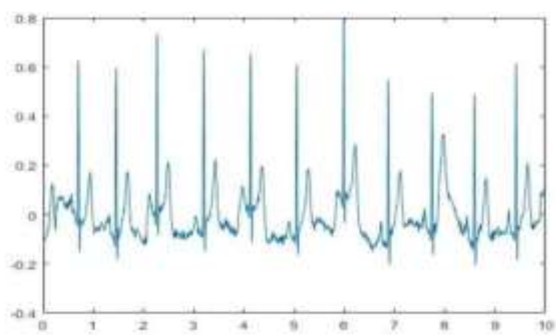
QR WAVEFORM

Finally, we get a clear ECG signal consists of the combination of P, Q, R, S, T and U waves. Thus, it can be calculated as

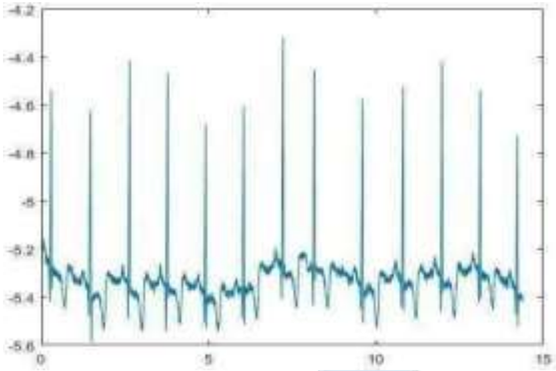
fECG = fQ(x) + fQRS(x) + fS(x) + fP(x) + fT(x) + fU(x)

Modelling fo Arrhythmias with Fourier Series:

Arrhythmias can be differentiated with the normal ECG based on heartbeat forms as it has irregular heartbeat forms unlike normal ECG signals. For example, Absence of some essential components of ECG like P, U wave and may be any other wave, extreme amplitudes value that is either very high or very low which results in either very high or very low heartbeat can be classified as arrhythmia. Fourier series is used here in order to model nine (9) arrhythmia types, by making various small changes in the final equation of normal ECG wave.



NORMAL ECG WAVE



ARRHYTHMIA WAVE

Reading Txt File Through Arduino and Display on Screen:

The Arduino Uno board, pre-modified with the Arduino boot loader is utilized in this venture. Arduino IDE form 1.0.3 on windows working framework is utilized as the programming IDE for this undertaking. The Arduino expert smaller than expected board has worked in ADC which peruses as well as changes into their computerized equal. The info arrives at the ADC with the assistance of information channels that are most extreme eight in number and are set apart in board as A0, A1 Bandwidth and Nyquist criterion any data which is in sampled form can be perfectly reconstructed - ―Nyquist-Shannon sampling theorem‖.

6. Results and Discussion

The implementation of the "Intelligent ECG Monitoring Using Biotelemetry" project yielded promising and practical results. The developed prototype successfully achieved real-time monitoring and wireless transmission of ECG data using Arduino UNO and ESP8266 microcontroller. The integration of MATLAB for signal processing and Bluetooth communication enabled dynamic, real-time visualization of ECG signals on mobile devices.

Data Acquisition and Signal Processing

The ECG signals were acquired using Ag/Cl electrodes connected through an analog front-end amplifier circuit. Signals were amplified, filtered, and transmitted to the Arduino UNO. The signals were digitized and processed using the MATLAB environment. Using Fourier Series models, ECG wave components such as P, Q, R, S, T, and U were successfully simulated and displayed.

Display and Wireless Communication

The processed ECG signals were effectively displayed on a 16x2 LCD screen. Additionally, the data was transmitted via the ESP8266 microcontroller using Bluetooth to an Android smartphone. The Android interface displayed the ECG waveforms in real-time, demonstrating the mobile integration capability of the system. samples subjected to fumigation treatments.

Performance and Accuracy

The system showed accurate detection of various ECG components and differentiation between normal and arrhythmia waveforms. The delay between signal acquisition and mobile display was minimal, allowing for near-instantaneous monitoring. The fidelity of the signals was preserved through efficient noise filtering techniques.

User Experience

The prototype was wearable, lightweight, and easy to use, which met the objective of ensuring patient comfort and mobility. The graphical interface on the mobile device was intuitive, displaying clearly segmented ECG waveforms for clinical interpretation

7. Conclusion

Utilizing remote innovation limits work area mess and repeats the solid market for innovation that takes into consideration straightforwardness in medical clinics and inside the house. A remote ECG sensor which shows its yield on PC utilizing Lab see. A gadget which permits effective checking for data of heart condition that is ongoing, persistent, and exact, remotely.

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